THE INTRODUCED NORTHERN PACIFIC SEASTAR *ASTERIAS AMURENSIS* IN TASMANIA

ROGER E. BUTTERMORE, ELIZABETH TURNER AND MARGARET G. MORRICE

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In early 1992 the northern Pacific seastar, *Asterias amurensis* was identified from Tasmanian waters. It is possible that larvae may have been released in discarded ballast water from overseas ships. Each adult female may release up to 19,000,000 eggs annually. The species is a serious predator of accessible marine fauna, particularly bivalve molluscs. Little is known of the impact of *A. amurensis* on its northern hemisphere habitat. The seastars appear to be thriving in Tasmanian waters and vast numbers have been observed around the Hobart waterfront. Research by the Tasmanian Museum includes surveys of present distribution and abundance of the seastar, data about its physico-chemical environment, aspects of its reproductive biology, and the species on which it preys. Future management of this pest in Australia may well depend on the information provided by this research. ☐ *Asterias amurensis, ballast water introductions, Echinodermata, Asteroidea, aquaculture, alien species, Tasmania, Australia.*

Roger E. Buttermore, Elizabeth Turner & Margaret G. Morrice, Tasmanian Museum, Hobart, Tasmania 7001, Australia; 30 March 1994

Recently the northern Pacific seastar *Asterias amurensis* has become established in southeastern Tasmanian waters. As a significant predator with high fecundity it is of particular concern to scientists, environmentalists and the aquaculture/fishing industries.

Larvae of the species may have been released in Tasmanian ports by the discharge of ballast water from bulk carriers. Intolerance of warmer water makes it unlikely that *A. amurensis* travelled through tropical latitudes by natural locomotion or on the hulls of ships (Munday et al., 1993). Two other recent introductions, a Japanese seaweed *Undaria pinnatifida* and a toxic dinoflagellate *Gymnodinium catenatum*, have already been linked to ballast water discharge. All three alien species currently are found around some Tasmanian port areas (Jones, 1991; Zeidler, 1992).

Seastars from Rosny Point in the Derwent River estuary were lodged with the Tasmanian Museum in October 1986, but were misidentified as the native seastar *Uniophora granifera*. The two species are very similar in appearance. The increase in the number of seastars was originally attributed to repopulation of *U. granifera* in a cleaner Derwent River, as a result of a reduction in effluent discharged by industries.

In 1992 Dr Wolfgang Zeidler of the South Australian Museum was sent a specimen and noticed that it did not conform to any known Tasmanian (or mainland Australian) species. Dr Loisette Marsh of the Western Australian Museum positively identified samples from Tasmania as *A. amurensis* (Turner, 1992).

DISTRIBUTION

The natural distribution of *A. amurensis* extends around the coast of Japan to Russia and through the Bering Sea. Reports of *A. amurensis* in Alaska and Canada are considered by Russian scientists to be the result of another accidental introduction (McLoughlin & Bax, 1993).

In Tasmania *A. amurensis* is found mainly in the waters of southeastern Tasmania. To date it has been sighted several kilometres upstream and downstream of Hobart, in Frederick Henry Bay, down the D'Entrecasteaux Channel to the Huon River estuary and on the east coast of Tasmania near Triabunna (Fig. 1). The seastars have been found in scallop spat bags, in mussel and oyster farms, and feeding on mussels living on the netting of salmon farm pens. They have also been reported in recreational fishing nets in the Derwent River where they have stripped the flesh off captured fish. From diving surveys in southeastern Tasmania the species is known to occur on various substrates including mud, sand and rock, and in water depths from littoral to 30 metres (Morrice, 1993). Surveys are currently underway by Tasmanian Museum staff to estimate the abundance of the seastar throughout its distribution.

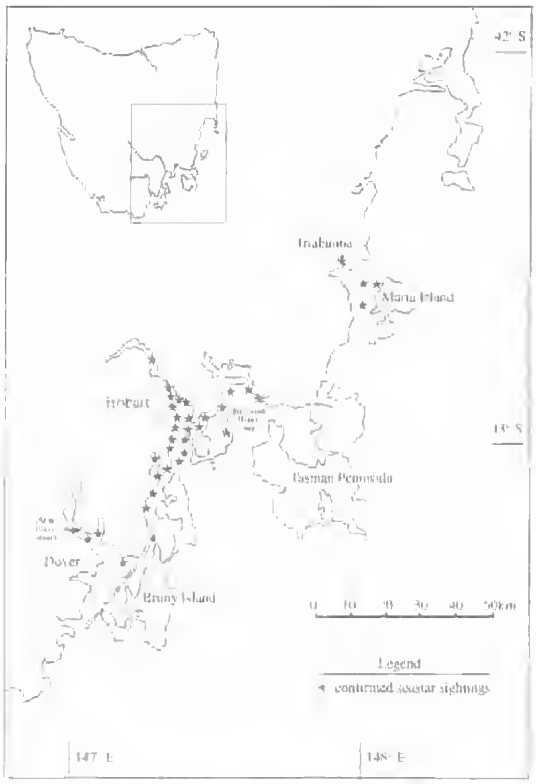

FIG. 1. Known distribution of the northern Pacific seastar *Asterias amurensis* in Tasmanian waters: based on confirmed sightings, diving and dredging surveys to mid-November 1993.

A computer simulation of egg and larval dispersal in Tasmania by Lyne (1993) predicts extensive spread of the seastar. Using biological information gathered from Japanese sources (Hawkes & Day, 1993) combined with Tasmanian wind data from 1988, the model forecasts dispersal to northern Tasmania and beyond. However, other factors such as temperature, food, substrate and mortality which would affect survival and settlement are yet to be included in the simulations

SEXUAL REPRODUCTION, GROWTH AND POPULATION DYNAMICS

Asterias amurensis is dioecious. Ovaries in ripe females are large with microscopic eggs (diameter 110-150µm) and each female may spawn up to 19,000,000 eggs annually (Kim, 1968; Kasyanov, 1988). Some *A. amurensis* females dissected in Hobart are so full of eggs from July to September that their gonads extend into the stomach cavity.

In Japan the main spawning event occurs during the winter-spring season from January to late April, peaking in late February (Takashi et al., 1955; Kim, 1968). In Tasmania, mean gonad indices indicate a major spawning event also occurs in winter-spring, peaking in early August (Fig. 2) (Morrice, 1993). Further sampling and histological information, particularly prior to the onset of spawning, will enable a more accurate assessment.

Fertilisation is external and larvae hatch into a short gastrula stage and develop through a free pelagic period. The length of the larval stage is still uncertain, however laboratory tests have cultured bipinnaria larvae for 40-60 days (Sagura & Ino, 1954; Kasyanov, undated).

Once the juvenile seastar has settled growth is rapid and it may mature in one year with a ray length of about 40mm (Kim, 1968). In Tasmania, gonads are present in seastars with a ray length greater than 55mm (Morrice, 1993). The largest specimen recorded thus far in Tasmania had a ray length of 203mm. In contrast, the largest record mentioned in available literature about northern Pacific specimens had a ray length of 192mm (Oguro, 1991). As with other Asteriidae species, damaged ray regeneration is common. New seastars can grow from severed rays if a piece of the central disc is still attached (Marsh, 1993).

In its northern Pacific habitat, particularly in the southern range, large variations in population density occur in three or ten year cycles, depending on the location. The density of seastars during these outbreak periods is approximately 4-6m^{-2} (Nojima et al., 1986). The outbreaks can last for

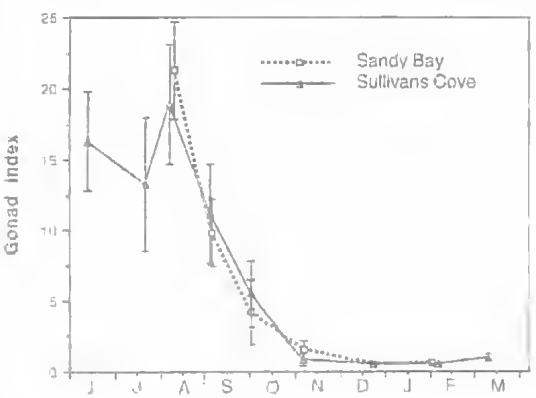

FIG. 2 The mean gonad index (±95% confidence limits) for *Asterias amurensis* at Sullivans Cove and Sandy Bay, Tasmania from June 1993 to March 1994.

FIG. 3. Typical feeding aggregation of *A. amurensis* on the mussel *Mytilus edulis planulatus*. Photograph by Bill Denholm.

two or three years. During these times the seastars swarm together in masses on the seabed, and particularly on any available food. In the docks at Hobart, the mean abundance of seastars at Macquarie Wharf in August 1993 at a depth of 10m was 9.44m^{-2}. The highest concentrations occur on dumped fish carcasses (an illegal practice) and live mussels (Fig. 3).

FEEDING

Tasmanian Museum researchers have observed *A. amurensis* feeding on bivalve and gastropod molluscs, barnacles, crabs, other crustaceans, brittle-stars, worms, sea cucumbers, other seastar species (including their own kind), ascidians, and drowned dogs. The stomach is everted to digest a food item. *Asterias amurensis* is an opportunistic feeder but will select certain prey if available. Japanese studies have shown that the preferred prey are mussels and oysters with a shell height equal to the length of the seastar's ray (Kim, 1969b; Park & Kim, 1985). Bivalve molluscs are eaten after the shells have been prised apart by the rays. *Asterias amurensis* will dig shallow pits in search of buried prey depending on prey depth (Kim, 1969a). Feeding aggregations of other *Asterias* species release chemical stimuli which attract their own kind (Zafiriou, 1972; Hawkes & Day, 1993).

SEASONAL VARIATIONS

Anecdotal evidence has suggested a seasonal migration of *A. amurensis* in Japan (Nojima et al., 1986). In Tasmania preliminary research has begun to establish whether the seastars undergo migration from shallow to deeper water in the summer to avoid warmer water. Surveys are being conducted in various depths at three sites to test for significant changes in abundance. Already a change in mean abundances of seastars has been recorded at a depth of 10 m at Macquarie Wharf, Hobart, from 9.44m^{-2} in August 1993 to 2.33m^{-2} in December 1993 (Morrice, 1993).

POSSIBLE DAMAGE TO ECOLOGY AND INDUSTRY

In the northern hemisphere *A. amurensis* is a serious predator on commercial scallops and a threat to the trawl-fishing industry (Hatanaka & Kosaka, 1959; Kim, 1968). Japanese and Russian studies of the species have concentrated on its physiology, biochemistry and embryology but no specific research on its ecology has been undertaken. McLoughlin & Bax (1993) note an apparent low biodiversity off the temperate Russian coast, but this may not necessarily be attributed to *A. amurensis*. The ongoing effect on ecology by the seastar in southern Tasmania is being measured in diving surveys conducted by the Tasmanian Museum recording the number and diversity of the seastar's prey species. As there are no baseline data on biodiversity in areas where *A. amurensis* has already become established, it is therefore very difficult to measure its impact on the original ecology of these communities.

CONTROL MEASURES

No fully effective solutions to the population outbreaks in the northern Pacific have been found apart from localised trapping and dredging at marine farms in Japan (McLoughlin & Bax, 1993). There is also little recorded evidence in Japan and Russia on natural predators, parasites or diseases apart from accounts of predation by the seastar *Solaster paxillatus*, and the presence of a parasitic gastropod and ciliophoran (McLoughlin & Bax, 1993). Russian scientists have observed the Alaskan King crab *Paralithodes camtschatica* preying on *A. amurensis* in an aquarium (Mikulich & Berulina, 1972).

As the population outbreak of *A. amurensis* is relatively contained to the southeast Tasmanian region, immediate short term controls should be implemented in addition to research into long term biological controls to prevent the seastar spreading further. Recommendations provided so far on short term control measures include removal by diver, use of baited traps, and treatment of seawater being transported from affected areas particularly during and after the spawning season. Trials are currently underway on a seastar trap designed by a local fisherman to test its catch effectiveness.

In an effort to highlight the extent of the problem, to instigate action to remove the seastar and to collect information for research, the Tasmania Museum, in association with professional and recreational divers, held two major dives in the Hobart docks during the 1993 winter. Over 30,000 seastars were collected and donated to Dr Martin Line of the University of Tasmania for experimental composting trials. Results thus far are promising (Line, pers. comm.).

CURRENT RESEARCH

A 16 month research program for 1993-94 is being funded by the Feral Pests Program of the Australian Nature Conservation Agency. The grant is the first awarded for study of an introduced marine pest. Two researchers are currently employed full-time by the Tasmanian Museum in Hobart.

Assistance in determining the extent of distribution has been sought from the public, aquaculture farmers and fishermen. A pamphlet has been available from the Tasmanian Museum since 1992 to assist people to distinguish between the native species *U. granifera* and *A. amurensis*, and to report sightings. An updated pamphlet is presently in production. A colour poster jointly produced by the National Seastar Task Force, the Tasmanian Museum and CSIRO Division of Fisheries to assist with identification is now available from various agencies.

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